# Space Weather Technical Forecast

Issued on Friday, 23 February 2024 at 13:26 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

**Space Weather Forecast Headline: High solar activity associated with AR3590.**
**Current strongest flare of the solar cycle recorded with a chance of further X-class flares.**

**Solar Activity:** Solar activity has been High over the past 24 hours, with a peak X6.3 flare recorded at 22/2234 UTC from AR3590 in the northeast, this being the strongest flare of the current solar cycle. AR3590 continues to be, by far the largest and most complex of the seven sunspot regions on the visible disc. A small, but decaying delta spot within the main intermediate region remains and there has been some slight consolidation of the other spots within the group. The remaining regions are much smaller and appear simpler, however, one region close to the southeast limb likely contains the previously highly active Ex-AR3575. This and a further two regions close to the eastern horizon may reveal more complexity as they rotate into clear view on the disc.

A minor CME was observed leaving the sun in coronagraph imagery following the X6.3 flare, however this appears to be directed to the east of the Earth-Sun line, with any Earth-directed component considered unlikely.

**Solar Wind / Geomagnetic Activity:** Solar winds, as observed by ACE have been at ambient speed throughout, with density predominantly at below average levels. Total magnetic field strength has been weak, below 8nT, with the north-south component initially weakly negative, but becoming mainly weakly positive from around 22/1700UTC. Phi angle was largely positive (away from the Sun), but became mostly negative (towards the Sun) from around 23/0900 UTC. Geomagnetic activity was Quiet (Kp0-1).

**Energetic Particles / Solar Radiation:** GOES18 high energy (greater than 10MeV) proton flux was slightly above normal background levels, but well below the S1/Minor Radiation Storm threshold. Electron flux (greater than 2MeV) observed at GOES16 has been at normal background levels, with electron fluence well below the Active (1e8 integrated pfu) threshold. The observed 24-hour fluence at 23/0001UTC was 1.05e6 integrated pfu.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Activity is forecast to remain Moderate to High, with occasional M-class flares expected and a chance of further isolated X-class flares, particularly in the near term, from AR3590.

**Solar Wind / Geomagnetic Activity:** A large filament was observed leaving the northwest of the disc around 21/1730UTC and is modelled to perhaps give a glancing blow late on day 2 (24 Feb) or more likely early on day 3 (25 Feb). No other CMEs currently feature in the forecast. Current solar winds are near background values but the high speed stream associated with CH01/- currently near centre disk is expected to connect with Earth perhaps as early as day 2 (24 Feb) but more likely by day 3 (25 Feb), and persist through the remainder of the period. Peak speeds expected around 500km/s. Geomagnetic activity is forecast to remain Quiet initially. Unsettled to Active intervals are then considered likely due to the onset of the high speed stream on days 2 and 3 (24/25 Feb), with a chance of G1/Minor storm intervals, particularly if connection to the high speed stream and the glancing blow from the filament CME

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occur at similar times.

**Energetic Particles / Solar Radiation:** GOES18 high energy (greater than 10MeV) proton flux is expected to continue at generally background levels or just above, but AR3590 will become an increasing source of potential proton response as the region moves towards and beyond centre disc through the forecast period, with a slight but increasing chance of S1 Minor Radiation Storms.

High energy electron flux (greater than 2MeV) is expected to generally remain at normal background levels, although an increase to moderate or high levels is perhaps possible by day 4 (26 Feb). 24-hour electron fluence is expected to stay below the Active (1e8 integrated pfu) threshold throughout.

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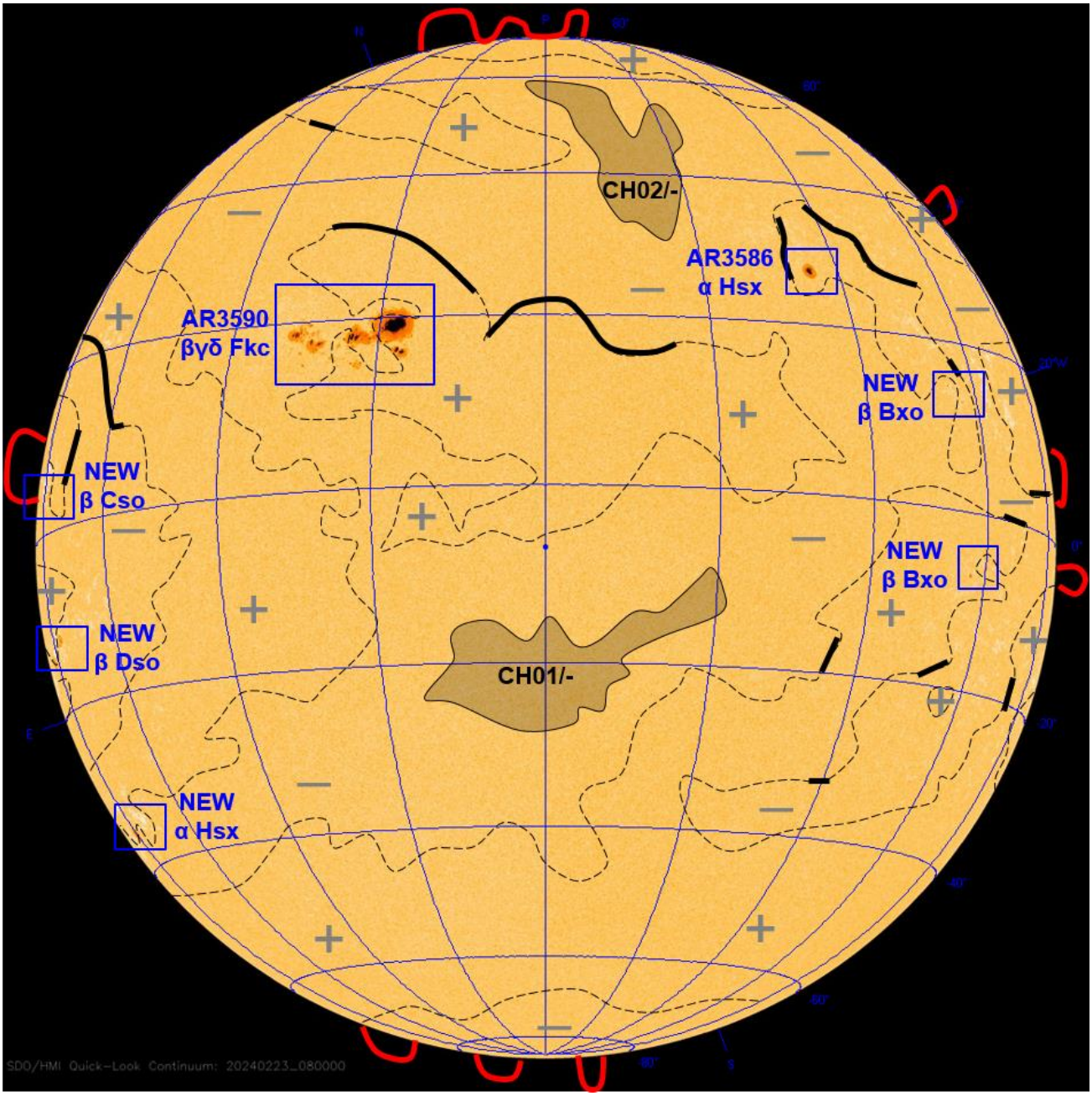
**Figure 1. Solar Analysis Valid 23/0800 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

A large filament was observed leaving the northwest of the disc around 21/1730UTC and is modeled to perhaps give a glancing blow late on day 2 (24 Feb) or more likely early on day 3 (25 Feb). No other CMEs currently feature in the forecast.

Current solar winds are near background values but the high speed stream associated with CH01/- currently near centre disk is expected to connect with Earth perhaps as early as day 2 (24 Feb) but more likely by day 3 (25 Feb), and persist through the remainder of the period. Peak speeds associated with this feature on the last rotation reached around 500km/s, with similar values considered likely. Geomagnetic response was fairly muted on the last rotation although expected response may be slightly stronger as we move closer to the March equinox.

Geomagnetic activity is forecast to remain Quiet initially. Unsettled to Active intervals are then considered likely due to the onset of the high speed stream on days 2 and 3 (24/25 Feb), with a chance of G1/Minor storm intervals, particularly if connection to the high speed stream and the glancing blow from the filament CME occur at similar times.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 1 | 10 | 30 | 10 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed | Estimated Arrival Time | Comments |
|---|---|---|---|---|---|---|
| 22/0257 | Partial | Filament eruption | NW | 425km/s | 25/1000 UTC | Glancing blow |

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## Radio Blackouts - X-Ray Flares:

Solar activity has been High in the past 24hrs, with a peak X6.3 flare recorded at 22/2234 UTC from AR3590. This large region has been active with a history of several X-class flares in recent days. Some consolidation of its spots has occurred, including the large leader and main intermediate spot. Meanwhile, the previous delta spot within the intermediate spot has largely decayed. The region provides the vast majority of current flare risk, increased from statistical values given recent activity.

The remaining regions are much smaller and appear simpler, however, one region close to the southeast limb likely contains the previously highly active Ex-AR3575. This and a further two regions close to the eastern horizon may reveal more complexity as they rotate into clear view on the disc. These regions likely act to maintain the flare risk into the coming days.

For now activity is forecast to remain Moderate to High, with occasional M-class flares expected and a chance of further isolated X-class flares, particularly in the short term, from AR3590. The risk is allowed to decline towards more expected statistical levels into the period pending further developments of AR3590 and classification of the new regions.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | Yes | 80 | 80 | 75 | 70 |
| Very Active | R3 to R5 X Class | Yes | 40 | 40 | 30 | 20 |

**Figure 2: HMI-Intensitygram flattened (left) and HMI-Colorized Magnetogram of AR3590 at 23/1230 UTC (right)**

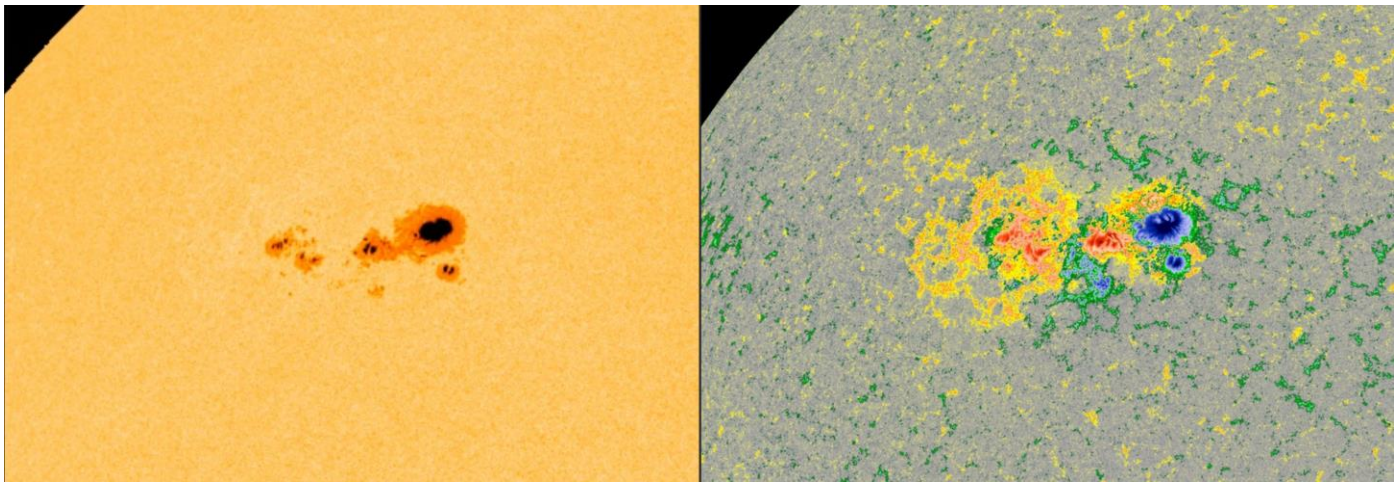

**Figure 3: SDO/AIA 94 (above) at 23/1303 UTC and SDO/AIA 171 (below) at 23/1306 UTC.**

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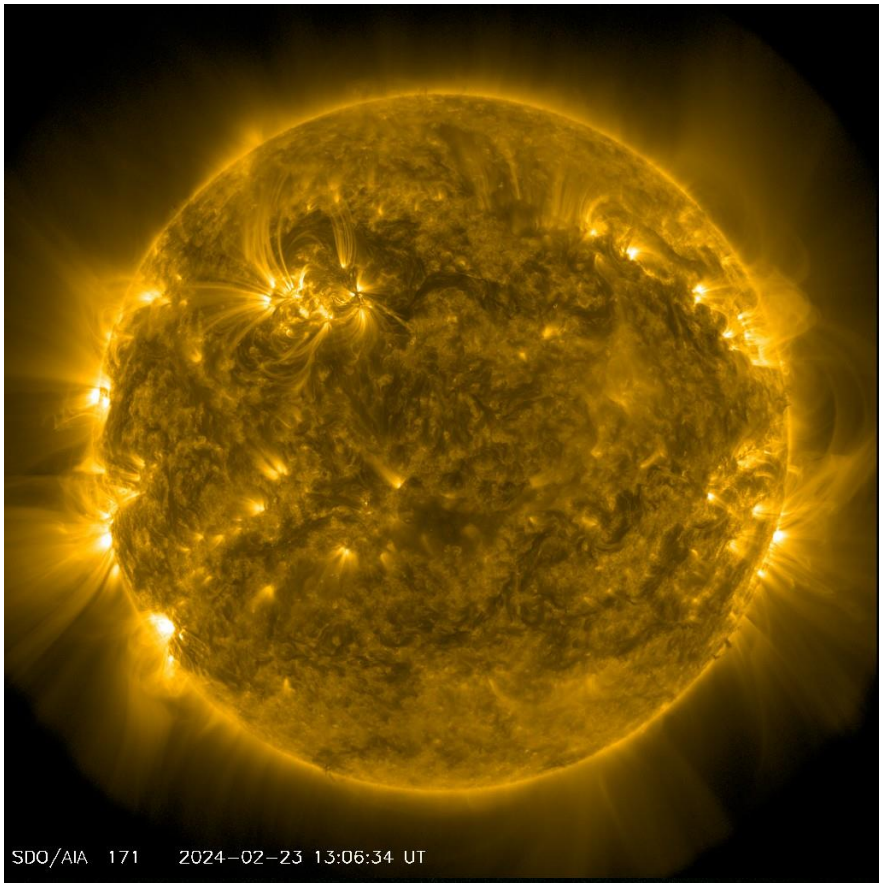


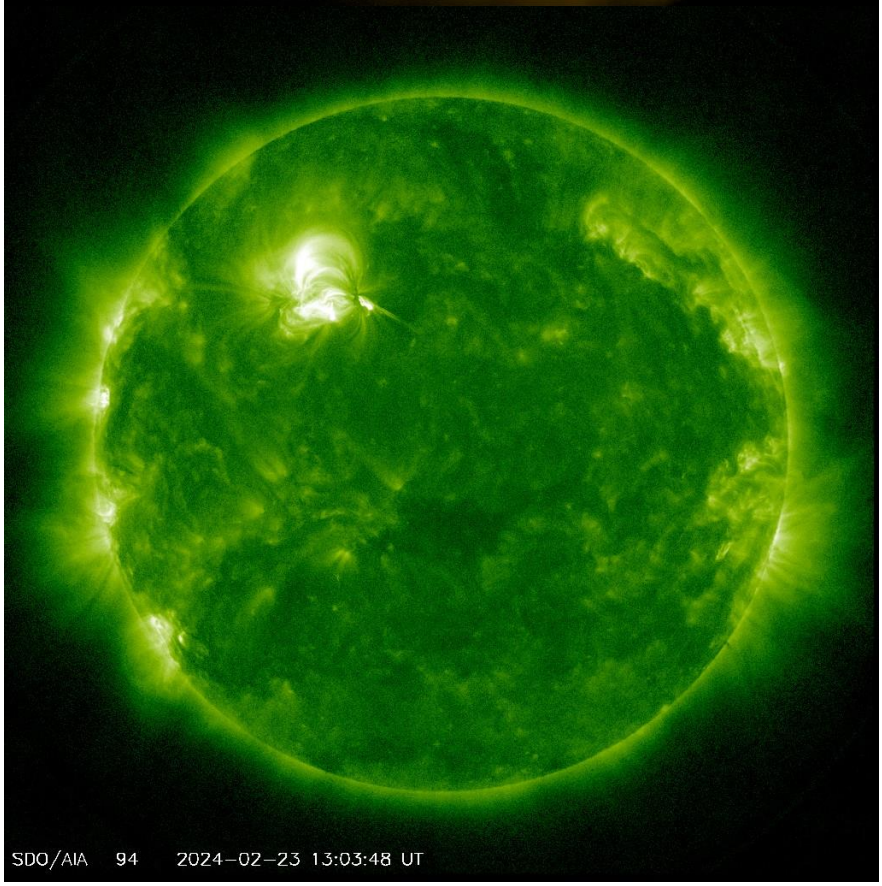


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## Solar Radiation Storms - (High Energy Protons):

GOES18 high energy (greater than 10MeV) protons is slightly above normal background levels, in response to the X6.3 flare from AR3590 at 22/2234 UTC, but is well below the S1/Minor Radiation Storm threshold.

The proton response to the recent strong flare is expected to continue, although significant enhancement is not expected given the current position of the source region. AR3590 will become an increasing source of potential proton response as the region moves towards and beyond centre disc through the forecast period however, particularly given the recent history of activity, with a slight but increasing chance of S1 Minor Radiation Storms.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 10 | 15 | 20 | 25 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

## High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) is currently at background levels, with any significant enhancement from glancing CME blow or high speed stream into days 2 and 3 (24/25 Feb) likely to be observed later in this forecast period, with an increase to moderate or high levels perhaps possible by day 4 (26 Feb).

Electron fluence values are expected to remain below the Active threshold during the forecast period with MOSWOC REFM model currently thought to be giving good guidance.

| GEO Electron Environment Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | No | 1 | 1 | 1 | 5 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 1 | 1 |

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**Figure 4: Latest GOES-16 >2MeV Electron Flux (above) and MOSWOC REFM with recurrence (below)**

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